Active Project (2014 - 2017)

Autonomous Systems and Operations Project

Advanced Exploration Systems Program | Human Exploration And Operations Mission Directorate (HEOMD)

ABSTRACT

The AES Autonomous Systems and Operations (ASO) project will develop an understanding of the impacts of increasing communication time delays on mission operations, develop autonomy technologies to mitigate the impacts, and infuse them into Human Exploration and Operations systems. The technologies are expected to reduce operations costs as well. This technology has been tested on ISS in FY14-15 as part of the AES Autonomous Mission Operations project; future tests will take place in FY16 and FY17-18. This technology has also been tested in the Integrated Power, Avionics and Software (IPAS) facility at JSC, and in a testing facility during Exploration Flight Test 1 (EFT-1).

This project incorporates and builds on the results from the AES Autonomous Mission Operations project.

ANTICIPATED BENEFITS

To NASA funded missions:

Reduced operational costs for human exploration beyond low Earth orbit.

To NASA unfunded & planned missions:

Reduced operational costs for human exploration beyond low Earth orbit.

To other government agencies:

Reduced operational costs for human exploration beyond low Earth orbit.

To the commercial space industry:

If this technology is used, it could reduce operational costs for human exploration beyond low Earth orbit.

To the nation:

Reduced operational costs for human exploration beyond low Earth orbit.

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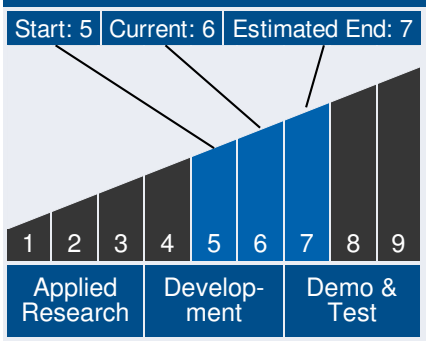
Technology Maturity



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DETAILED DESCRIPTION

Future human spaceflight missions will occur with crews and spacecraft at large distances, with long communication delays to the Earth. The one-way light-time delay to the Moon is 1.3 seconds, which is sufficient to make some scenarios (e.g., landing) difficult or impossible to conduct from Earth. One-way communication delays to human exploration destinations such as Near Earth Asteroids (NEA) range from seconds to minutes. The one-way light-time delay to Mars ranges from 3 minutes (at conjunction) to 22 minutes (at opposition). As the communication delays increase, the crews in the spacecraft must execute, and manage, much of the mission themselves. Throughout the course of a mission, as distances increase, NASA must continue to migrate operations functionality from the remote Mission Control Center flight control room to the vehicle for use by the crew. The role of the ground control teams and systems will evolve away from real-time support to a more long-range planning, diagnosis, analysis, and prognostics support role, while the vehicle systems and crew must take on the role of onboard daily schedule execution, planning, and systems management. Both ground and vehicle systems will require automation to maximize crew functionality, minimize unnecessary overhead, and reduce operating costs. This project is to understand the impacts of increasing communications time delays on operations and to develop technologies to mitigate the impacts.

Realized Benefits

2 Publications

Management Team

Program Director:
- Jason Crusan

Program Executive:
- Richard Mcginnis

Project Manager:
- Jeremy Frank

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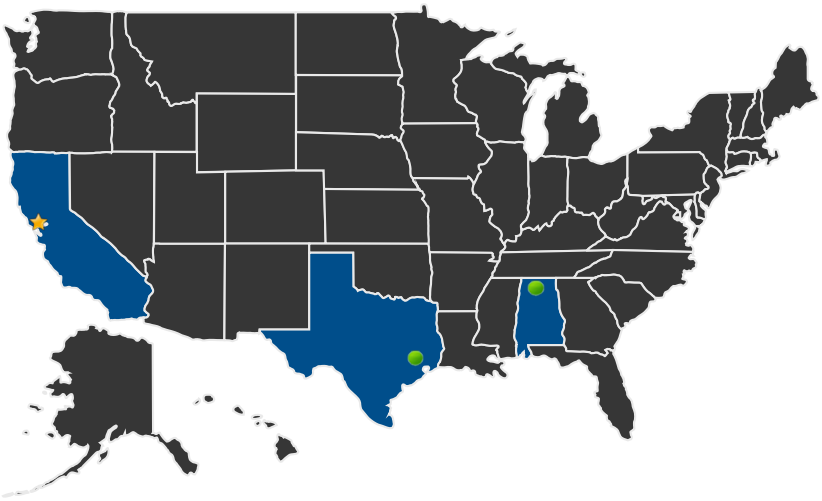
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Supporting Centers:

- Johnson Space Center
- Marshall Space Flight Center

PROJECT LIBRARY

Publications

- Autonomous startup of an Experiment Rack on ISS
  - (http://techport.nasa.gov:80/file/26176)
- Success Story - Advanced Caution and Warning System
  - (http://techport.nasa.gov:80/file/26175)

Technology Areas

Primary Technology Area:
Robotics and Autonomous Systems (TA 4)
└ System-Level Autonomy (TA 4.5)
└ System-Level Autonomy (TA 4.5)
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Internetworking (TA 5.3)
└ Disruption-Tolerant Networking (TA 5.3.1)
└ Disruption Tolerant Networking (DTN) Basic Services (TA 5.3.1.1)

Secondary Technology Area:
Robotics and Autonomous Systems (TA 4)
└ Human-System Interaction (TA 4.4)
└ Human-System Interaction (TA 4.4)

Robotics and Autonomous Systems (TA 4)
└ Systems Engineering (TA 4.7)
└ Systems Engineering (TA 4.7)

Continued on following page.

Technology Areas *(cont.)*

Ground and Launch Systems (TA 13)
- Reliability and Maintainability (TA 13.3)
  - Communications, Networking, Timing, and Telemetry (TA 13.3.7)
    - Advanced Networking Protocols for Delay-Tolerant Networking (TA 13.3.7.3)

DETAILS FOR TECHNOLOGY 1

Technology Title

Autonomous Systems and Operations

Technology Description

This technology is categorized as software memory for manned spaceflight

Future human spaceflight missions will occur with crews and spacecraft at large distances, with long communication delays to the Earth. The one-way light-time delay to the Moon is 1.3 seconds, which is sufficient to make some scenarios (e.g., landing) difficult or impossible to conduct from Earth. One-way communication delays to human exploration destinations such as Near Earth Asteroids (NEA) range from seconds to minutes. The one-way light-time delay to Mars ranges from 3 minutes (at conjunction) to 22 minutes (at opposition). As the communication delays increase, the crews in the spacecraft must execute, and manage, much of the mission themselves. Throughout the course of a mission, as distances increase, NASA must continue to migrate operations functionality from the remote Mission Control Center flight control room to the vehicle for use by the crew. The role of the ground control teams and systems will evolve away from real-time support to more long range planning, diagnosis, analysis and prognostics support role. While the vehicle systems and crew must take on the role of onboard daily schedule execution, planning, and systems management. Both ground and vehicle systems will require automation to maximize crew functionality, minimize unnecessary overhead, and reduce operating costs. This project is to understand the impacts of increasing communications time delays on operations and to develop technologies to mitigate the impacts.

Capabilities Provided

The technologies developed will enable effective crew and system operation regardless of disruptions or time delays in communications between the in-space segment and the Earth-based mission operations center.

Potential Applications

Initially, the intended application is for human exploration missions beyond low Earth orbit. The technology is not specific to this and can be applied anywhere autonomous systems are desired. This may be on in-space or planetary robotic spacecraft, dormant human occupied spacecraft, or in control centers.